

**SEVENTEENTH PERIODIC SOIL VAPOR
SAMPLING RESULTS
APRIL 2004**

AT THE

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JET PROPULSION LABORATORY
PASADENA, CALIFORNIA**

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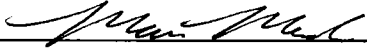
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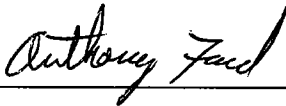
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ACRONYMS AND ABBREVIATIONS

| | |
|--------------------|---|
| bgs: | Below Grade Surface |
| BTEX: | Benzene, toluene, ethylbenzene and xylenes |
| cc: | Cubic Centimeter |
| CCl ₄ : | Carbon Tetrachloride |
| CDHS: | California Department of Health Services |
| CRWQCB: | California Regional Water Quality Control Board |
| %D: | Percent Difference |
| DCE: | Dichloroethene |
| Freon 11: | Trichlorofluoromethane |
| Freon 113: | 1,1,2-trichloro-1,2,2-trifluoroethane |
| FWENC: | Foster Wheeler Environmental Corporation |
| GC: | Gas Chromatograph |
| GEOFON: | GEOFON, Incorporated |
| JPL: | Jet Propulsion Laboratory |
| NASA: | National Aeronautics and Space Administration |
| OD: | Outside Diameter |
| OU-2: | Operable Unit 2 |
| PCE: | Tetrachloroethene |
| QA/QC: | Quality Assurance / Quality Control |
| RI: | Remedial Investigation |
| TCA: | Trichloroethane |
| TCE: | Trichloroethene |
| µg/L: | Micrograms per Liter |
| VOC: | Volatile Organic Compound |

1.0 INTRODUCTION

Presented in this report are the results of the seventeenth periodic soil vapor sampling event completed as part of the periodic monitoring program being conducted at the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL) for Operable Unit 2 (OU-2) (on-facility soils). The purpose of this program is to monitor the horizontal and vertical distributions of volatile organic compound (VOC) vapors in the vadose zone beneath the JPL site.

From April 6 through April 9, 2004, GEOFON, Inc. (GEOFON) personnel collected soil vapor samples from all available soil vapor sampling tips located in soil vapor monitoring well No. 4, No. 17, No. 26, No. 27, No. 33, No. 35, No. 36, No. 37, No. 38, and No. 39. The locations of the soil vapor monitoring wells are shown in Figure 1-1. The set of soil vapor monitoring wells included in this sampling event is based on the soil vapor sampling frequency developed for the periodic monitoring program. A summary of the soil vapor sampling frequency is presented in Table 1-1.

All soil vapor samples collected during this event were analyzed for VOCs by H&P Mobile Geochemistry in an on-site laboratory that is certified by the California Department of Health Services (CDHS). The analyses were performed in accordance with EPA Method 8260B and the California Regional Water Quality Control Board, Los Angeles Region (CRWQCB-LA), protocols and guidance.

Sampling procedures are described in Section 2.0, and a summary of all VOCs detected during this seventeenth periodic soil vapor sampling event, including locations and depths, is contained in Section 3.0. Conclusions are provided in Section 4.0. A soil vapor data validation report for all samples analyzed during this sampling event is included in Appendix A and summarized in Section 5.0. Cited references are listed in Section 6.0. Laboratory reports for all samples analyzed, along with chain-of-custody forms, are included in Appendix B. The daily calibration verification standards for each day's sampling are also included in Appendix B. Appendix C contains a summary of soil vapor sampling results from all events conducted during the duration of this periodic monitoring program.

2.0 SOIL VAPOR SAMPLING PROCEDURES

From April 6 through April 9, 2004, soil vapor samples were collected and analyzed from ten (10) soil vapor monitoring wells that contained at least one open sampling tip. Soil vapor samples were collected from soil vapor monitoring well Nos. 4, 17, 26, 27, 33, 35, 36, 37, 38, and 39. Thirty-seven (37) depth-specific vapor samples, including four (4) duplicate samples, were collected and analyzed for 25 primary target VOC compounds in accordance with CRWQCB (1997) guidance documents. A description of the soil vapor well construction procedures was presented in the first long-term soil vapor sampling report prepared for OU-2 (FWENC, 2000a). Soil vapor well construction details are summarized in Table 2-1 of this report.

Soil vapor samples were withdrawn from the soil through the sampling tips and 1/8-inch-outside diameter (OD) Nylaflow® tubing using calibrated, gas-tight, 60-cubic-centimeter (cc) sterile syringes fitted with a three-way on-off valve. Prior to collecting the soil vapor sample, four volumes of the length of the tubing were purged to flush the tubing and fill it with in-situ soil vapor. Since each foot of tubing has an internal volume of 1 cc, the total volume purged was easily measured with the calibrated syringes. Following purging, a 60-cc soil vapor sample was collected in the syringe, the valve was turned to the off position, and the sample was immediately transferred to the on-site mobile laboratory for analysis. During sampling, neither water vapor nor condensation was observed in the transparent sampling syringes. Because the purge and sample volumes were small, a vacuum pump was not required to evacuate the tubing or to collect a soil vapor sample. To demonstrate reproducibility of results, a duplicate soil vapor sample was collected and analyzed after every ten environmental samples. The previous one in five (20%) duplicate sampling regimen was reduced during the twelfth quarter to one in ten (10%) duplicates collected.

The samples were analyzed on-site in a mobile laboratory certified (Certification No. 1667) by the CDHS to perform analyses by EPA Method 8260B and presented in the 8021 format for the parameters listed in Table 2-2. The time between sample collection and analysis was, at most, only a few minutes.

3.0 ANALYTICAL RESULTS

The results from the previous remedial investigation (RI) for OU-2 (FWENC, 1999) indicated that four VOCs were more frequently detected in soil vapor samples at elevated concentrations relative to other VOCs. These four VOCs are carbon tetrachloride (CCl_4), 1,1,2-trichloro-trifluoroethane (Freon 113), trichloroethene (TCE), and 1,1-dichloroethene (1,1-DCE). During the seventeenth periodic sampling event, the same four compounds (Freon 113, CCl_4 , 1,1-DCE, and TCE) were the most common chemical compounds detected in several of the ten (10) sampled soil vapor monitoring wells.

CCl_4 was detected in soil vapor monitoring well No. 39 at a depth of 100 feet with a concentration of 2.3 micrograms per liter of vapor ($\mu\text{g/L}$ -vapor). During this event, CCl_4 was not detected above the laboratory-reporting limit in the soil vapor monitoring well No. 4, 17, 26, 27, 33, 35, 36, 37, and 38.

Freon 113 was detected in soil vapor monitoring well No. 39 at a concentration of 8.1 $\mu\text{g/L}$ -vapor in the sample collected at a depth of 85 feet and a concentration of 9.2 $\mu\text{g/L}$ -vapor in the sample collected at a depth of 100 feet. A concentration of 1.2 $\mu\text{g/L}$ -vapor was detected in soil vapor monitoring well No. 35 at a depth of 140 feet. During this event, Freon 113 was not detected above the laboratory-reporting limit in the soil vapor monitoring well No. 4, 17, 26, 27, 33, 36, 37, and 38.

TCE was detected in soil vapor monitoring well No. 4 at a concentration of 24.0 $\mu\text{g/L}$ -vapor in the sample collected at a depth of 20 feet and a concentration of 14.0 $\mu\text{g/L}$ -vapor in the sample collected at a depth of 56 feet. A concentration of 1.9 $\mu\text{g/L}$ -vapor was detected in soil vapor monitoring well No. 17 at a depth of 36 feet. TCE was also detected in soil vapor monitoring well No. 39 at a concentration of 1.1 $\mu\text{g/L}$ -vapor in the sample collected at a depth of 85 feet and a concentration of 4.4 $\mu\text{g/L}$ -vapor in the sample collected at a depth of 100 feet. During this event, TCE was not detected above the laboratory-reporting limit in the soil vapor monitoring well No. 26, 27, 33, 35, 36, 37, and 38.

1,1-DCE was detected in soil vapor monitoring well No. 33 at a concentration of 1.0 $\mu\text{g/L}$ -vapor in the sample collected at a depth of 105 feet. 1,1-DCE was not detected above the laboratory-reporting limit in the remaining nine (9) soil vapor monitoring wells sampled during this event.

In addition, several other chemical compounds were detected in soil vapor monitoring well No. 17, including 1,2-dichloroethane (1,2-DCA), tetrachloroethene (PCE), benzene, ethylbenzene, and m&p-xylenes at concentrations of 7.8 $\mu\text{g/L}$ -vapor, 5.9 $\mu\text{g/L}$ -vapor, 76 $\mu\text{g/L}$ -vapor, 2.9 $\mu\text{g/L}$ -vapor, and 11 $\mu\text{g/L}$ -vapor, respectively.

A summary of the analytical results for all samples collected during this sampling event is presented in Table 3-1 and the analytical laboratory reports are presented in Appendix B-1. Chain-of-custody forms are included in Appendix B-2. Daily Opening, Closing, and Continuing Calibration Verification

Reports are included in Appendix B-3. Data from all periodic monitoring events conducted to date have been tabulated and are presented in Appendix C. Location maps for detections at depth for CCl_4 , Freon 113, TCE, and 1,1-DCE are shown in Figures 3-1, 3-2, 3-3, and 3-4, respectively. Total VOC concentrations at depth are presented in Figure 3-5.

4.0 CONCLUSIONS

The following conclusions are based on the results of the soil vapor sample laboratory analyses and the site conditions at the time of the seventeenth periodic sampling event (April 2004):

- VOCs were detected in only five (Nos. 4, 17, 33, 35, and 39) of the ten soil vapor monitoring wells sampled during this event. Concentrations of CCl_4 detected during this sampling event in soil vapor monitoring well No. 39 were similar to those measured during the previous sampling event and lower than those measured during the OU-2 RI.
- Freon 113 concentrations detected in soil vapor monitoring wells No. 35 and No. 39 were lower than those measured during the previous sampling event.
- TCE concentrations detected in soil vapor monitoring wells No. 17 and No. 39 were slightly lower than those measured during the previous sampling event.
- Concentrations of TCE detected in soil vapor monitoring well No. 4 were slightly higher than those measured during the previous sampling event. A low concentration of 1,1-DCE was detected in soil vapor monitoring well No. 33, which was slightly higher than the sample measured in the previous event at 105 feet.
- In addition to the above VOCs, low concentrations of 1,1,1-DCA, PCE, benzene, ethylbenzene, and m&p xylenes were also detected in soil vapor monitoring well No. 17.
- Based on the results of soil vapor samples collected during this sampling event, VOC concentrations generally continue to decline throughout the site.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

This section briefly summarizes the quality assurance and quality control (QA/QC) procedures followed during the seventeenth periodic soil vapor-sampling event. Analytical data reports for all soil vapor samples were sent to Laboratory Data Consultants, located in Carlsbad, California, for independent data evaluation. All data was usable as qualified. The validated data reports are presented in Appendix A - Soil Vapor Data Validation Reports.

All sample analyses were performed using an external, three-point standard calibration method. For most target analytes, both detectors on the gas chromatograph (GC) were calibrated over a range equivalent of 5.0 to 200.0 µg/L of analyte in soil vapor. Analytical system performance was verified at the beginning of each analytical day with an "opening standard" and a "closing standard" after the last environmental sample analysis for the day. A "continuing standard" was analyzed after the tenth environmental sample run that day. If ten or fewer samples were analyzed during the day, the closing standard substituted for the continuing standard. Results of daily opening, closing, and continuing (if applicable) standards are presented in Appendix B-3.

During each analytical day, the environmental sample analyses were bracketed by check standards, which verified acceptable system performance for the analytes listed in the daily calibration data summary tables (Appendix B-3). The percent difference (%D) of calibration factors in continuing standard mixtures were less than or equal to 24.6 percent for selected compounds and less than or equal to 17.6 percent for all other compounds (see Appendix B-3).

Field blanks of ambient air from inside the field laboratory trailer were analyzed immediately after the opening verification standard and were clean in all cases. No matrix spikes or laboratory replicates were required.

Three surrogate compounds (dibromodifluoromethane, 1,2-dichloroethane-d4, and 4-bromofluorobenzene) were injected into the GC along with the environmental samples as a QA/QC check on recovery limits. In accordance with RWQCB (1997) protocols, surrogate recoveries should be in the range of 75 to 125 percent. All surrogate recoveries obtained during this sampling event satisfied this criteria by a wide margin, usually within a recovery range of 91 to 121 percent.

No sample analysis data obtained during this sampling event were rejected as unusable. Overall, the assessment of soil vapor and corresponding control sample data indicate that data quality objectives were achieved in terms of precision, accuracy, representativeness, comparability, and completeness for all analytes sampled.

6.0 REFERENCES

- Battelle. 2001. *Technical Memorandum, Design, Construction, Operation, Optimization, and Monitoring Recommendations for the Soil Vapor Extraction (SVE) System, Operable Unit 2 (OU-2), Jet Propulsion Laboratory*. October
- CRWQCB (California Regional Water Quality Control Board, Los Angeles Region). 1997. *Interim Guidance for Active Soil Gas Investigation*. February 25.
- FWENC (Foster Wheeler Environmental Corporation). 1999. *Final Remedial Investigation Report for Operable Unit 2: Potential On-Site Contaminant Source Areas*. Volume 1. November.
- FWENC (Foster Wheeler Environmental Corporation). 2000a. *First Long-Term Soil Vapor Sampling Results, October 1998*. February.
- FWENC (Foster Wheeler Environmental Corporation). 2000b. *Second Long-Term Soil Vapor Sampling Results, October 1998*. February.
- FWENC (Foster Wheeler Environmental Corporation). 2000c. *Third Long-Term Soil Vapor Sampling Results, October 1998*. March.
- FWENC (Foster Wheeler Environmental Corporation). 2000d. *Fourth Long-Term Soil Vapor Sampling Results, January 2000*. April.
- FWENC (Foster Wheeler Environmental Corporation). 2000e. *Fifth Long-Term Soil Vapor Sampling Results, June 2000*. September.
- GEOFON (GEOFON, Inc.). 2001a. *Sixth Long-Term Soil Vapor Sampling Results, January 2001*. February.
- GEOFON (GEOFON, Inc.). 2001b. *Seventh Periodic Soil Vapor Sampling Results, July 2001*. November
- GEOFON (GEOFON, Inc.). 2001c. *Eighth Periodic Soil Vapor Sampling Results, November 2001*. January
- GEOFON (GEOFON, Inc.). 2002. *Ninth Periodic Soil Vapor Sampling Results, February 2002*. April
- GEOFON (GEOFON, Inc.). 2002. *Tenth Periodic Soil Vapor Sampling Results, May 2002*. July
- GEOFON (GEOFON, Inc.). 2003. *Fourteenth Periodic Soil Vapor Sampling Results, May 2003*. August

GEOFON (GEOFON, Inc.). 2003. *Fifteenth Periodic Soil Vapor Sampling Results, August 2003*. September

GEOFON (GEOFON, Inc.). 2004. *Sixteenth Periodic Soil Vapor Sampling Results, February 2004*. September.